Avantages et coûts du véhicule électrique pour les finances publiques : modèle d'évaluation intégrée et application au territoire français / Benefits and costs of electric vehicles for the public finances: integrated valuation model and application to France

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Benefits and costs of electric vehicles for the public finances: integrated valuation model and application to France

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Abstract

The development of electro-mobility, with electric motors replacing the internal combustion engine, raises issues relating to the environment, energy and industry. Within a given country, it would have an economic and social impact in many areas, in particular on governments. Our objective is to quantify the respective impacts on the public finances of an electrically powered or petrol fuelled private car.

In order to do this, we establish an integrated method of valuation, covering both manufacture and use of the vehicle, which locates these stages within or outside the country concerned. From a "depth" perspective, it incorporates the economic proceeds from the different activities and what they consume, and from a "breadth" perspective it incorporates the fiscal effects (VAT, fuel and energy taxes, tax on production, etc.) and the social effects (social contributions, unemployment benefits). The valuation method is based on an input-output model of the productive economy within a country, combined with mechanisms of fiscal and social transfer. We postulate the existence of an activity for the Manufacture of electric vehicles, and we include this within the consumption matrix associated with production.

We apply this method to France, and to a diverse range of scenarios regarding the place in which the vehicle is manufactured and used. From this assessment it emerges that the impact of a vehicle on the public finances is substantial: manufacture contributes approximately the purchase price excluding VAT, and usage adds an amount of the same order of magnitude. The *vast majority* of the revenues arise from the social contributions associated with production (approximately 70%); VAT accounts for almost 20%, tax on production around 5%, and energy surcharge 9% for an internal combustion vehicle or 1% for an electric vehicle. If it is both manufactured and used inside the country, then an electric vehicle might contribute very slightly more to the public finances than an internal combustion vehicle, before any purchase incentive bonus, which would markedly reverse the outcome. The worst scenario would be the use of an imported electric vehicle instead of a domestically manufactured internal combustion vehicle. At the other end of the scale, as an export product, an electric vehicle contributes substantially more to the public purse than an internal combustion vehicle.

Key words

Input-output model. Taxation. Social transfers. Life-cycle analysis.

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1. Introduction

1.1 Background

Plans for the industrial development and distribution of electric vehicles (EV) have recently come to the forefront of transport policies both in developed countries([2]) and in fast developing countries (China, India). The reason for this is the reduced environmental impact of such vehicles compared with internal combustion engine vehicles (ICV): at global level, fewer greenhouse gas emissions if the electricity comes from low carbon sources, and at local level reductions in traffic pollution and noise for improved quality of life. In a recent international journal (Leurent and Windisch, 2011), we showed that national policies to promote the use of electric vehicles are uniform in terms of the environmental claims they make and their scenarios for the diffusion of the electric car, entailing a three stage process: first, mass orders for large corporate fleets, then an extension to taxi fleets and public transport services, and finally a general spread to private households. There are some differences between national policies depending on their specific industrial and energy priorities, which affect the composition of the "policy package", between policies focusing on supply (R&D, industrial support) and those focusing on demand (subsidies for ownership and use, rollout of a battery charging infrastructure); the procurement consortium is a hybrid approach which aims to generate economies of scale on the supply side and reduce prices on the demand side.

The handful of economic studies of electro-mobility have focused on costs to the user, as a means of deciding which target target group to concentrate on.([3]) As far as we know, there has been no analysis so far of the national economic costs and benefits, although life-cycle analyses have demonstrated a reduction in environmental impact provided that certain electricity production conditions are met. In order to shift from the economic impact on the user to that on the nation, the economic impacts on the other parties concerned – in particular transport providers and central government – need to be considered. A socio-economic assessment of the overall impact has been attempted for France (CGDD, 2011), but it did not take into account industrial effects or social transfers.

1.2 Objective

Our objective is to evaluate the financial consequences, for the public purse, of replacing an internal combustion vehicle (ICV) with an electric vehicle (EV). These financial consequences are of different kinds: a specific policy to promote electric cars is only the tip of the iceberg; we want to show the hidden part, which includes industrial, fiscal and social factors. Industrial factors are here taken in their broad sense, referring to the various activities involved in economic production, in particular manufacturing and energy production, both in the construction of a vehicle and in the provision of products and services throughout its operating life.

The industrial aspects have economic and social implications for employment, and therefore for salaries, for social contributions by employers and employees and for workers' incomes. We include these social accounts, along with unemployment benefits, in the accounts of the government that sustains them. Moreover, the value added by economic production is taxable

[2] United States, Japan, Germany, France, United Kingdom, Italy, Spain, Denmark, etc.

[3] Cf. BCG 2009. CGDD 2011. CE Delft 2011. Deutsche Bank 2009. Draper 2009. Deutsche Bank 2011. ESMT 2011. Nemry 2011

and generates tax revenues, both on the consumption side (VAT) and on the production side (various taxes on production). Finally, energy (in particular fuel, but also electricity) is subject to specific taxes, similar in nature to public subsidies for electric vehicles, although the direction of the financial transfers is the opposite.

Obviously, all these effects relate to a particular country, with its own system of production and economic, social and fiscal arrangements at any given time, and also its own local form of vehicle use. Slightly less obvious but equally real, in geographical terms the territory defines a *domestic* authority, by contrast with the space beyond. Location is important: in principle, local production is more favourable to domestic governments than imports; the use of the vehicle, whether domestic or external, also needs to be spatially defined.

We provide generally applicable principles and a methodology of financial valuation, and we apply them to the specific case of the private car in France, taking the year 2007 as our baseline.

1.3 Method:vertical economic valuation

We evaluate the replacement of an ICV by an EV over their whole life-cycle, considering first the manufacture and then the use of the vehicle and the associated consumption. Usage is quantified by vehicle type (segment B) and annual mileage, which determine the attractiveness of the EV for a buyer (Windisch, 2011). We evaluate the industrial aspects for each type of vehicle using an input-output model for economic production in the country. This model describes production, external trade and consumption for each type of activity. For consumption, we make a distinction between final demand by households and public bodies, final demand by companies for capital goods (capital and depreciation) and intermediate consumption arising from production, specified for each production activity. We adapt the input-output model to the composition and specific consumption requirements of an EV. We also use the production accounts and employment statistics for each type of activity, in order to evaluate the fiscal and social effects.

Our evaluation is therefore situated within the general framework of economic and social activity, incorporating direct and indirect economic effects. We go beyond the conventional context of transport economics (e.g. Quinet, 1998), which focuses exclusively on transport service, by including the industrial and social aspects: the major effect is to refine the notion of cost to a consumer, by identifying the part of this cost that constitutes revenue for a supplier and is therefore not a dead loss – a pure cost element – in a wider system. Finally, our evaluation is sensitive to space and even more so to place: the “public authority” is an actor located within a geographical space, which determines its situation with respect to social, economic, industrial and energy factors.

1.4 Article plan

The rest of the article is structured into three main parts and a conclusion. First, we describe the evaluation method, setting out the principles – in particular the differentiation of manufacture and usage – and specifying an accounting model for the different effects (section 2). Then we describe in detail our sources and assumptions, for each type of vehicle, for metropolitan France in 2007 (section 3). We can then evaluate scenarios for the location where manufacture and usage take place, identifying the main elements and ordering them with respect to industrial, fiscal and social criteria (section 4).

In conclusion, we describe the scope and limitations of our method, and suggest further avenues of research (section 5).

2. Methodology: principles and valuation model

Step-by-step, we describe the calculation by vehicle and life-cycle (para 2.1), the input-output model of economic production (para 2.2), the taxation model for the activity, for trading and for energy (para 2.3), together with the social model (para 2.4), before going over the valuation formulas (para 2.5).

2.1 Calculation by vehicle and by life-cycle

In order to evaluate the economic effects of a type of vehicle – EV or ICV – we calculate the unit costs and revenues for the manufacture and then use of a car. This means that our calculation is marginalist and does not depend on the size of the vehicle stock, nor the annual volume of vehicle sales.

We distinguish two essential phases in the life-cycle of a car: first, the manufacturing phase, and second use of the vehicle by the consumer during its operating lifespan – without taking into account vehicle transfers between successive users.([4]) We use an annual basis for both manufacture and usage over the whole life-cycle: two perspectives are possible in this respect, either that of the manufacturer, who counts the vehicles built and sold per annum, or that of the vehicle owner, who spreads the purchase over the life-cycle of the vehicle and thinks in terms of annual operating costs. We choose to work with the vehicle sales flow, counting all the costs associated with manufacture in a single year and allocating all the running costs over the lifespan of the vehicle to that year.([5]) When thinking in terms of a stock of vehicles owned and used, the above values need to be divided by the lifespan in years.

We postulate that the total cost of ownership and usage for the user is sufficiently alike between EV and ICV for the difference to have no more than a negligible impact on the decision to buy, on the annual mileage covered by the user and on the length of ownership and therefore the economic lifespan of the vehicle.

In formal terms, $\delta \mathbf{Y}_J^t = [\delta Y_j^t : j \in J]$ is the annual consumption vector associated with vehicle type $t \in \{\mathrm{C},\ \mathrm{E}\}$, for the set J of production activities j.

2.2 Input-output model of economic production

The main activities associated with production include car construction, the manufacture of electrical equipment, metal products, textiles, the supply of car-related services and consumables, etc. We will identify the relevant items in the next section: for methodological purposes, we simply need to specify a set of activity types, J.

By activity type j, let X_j be the value produced annually within the study area, I_j the value of imports, E_j the value of exports, $K_{j\bullet}$ the intermediate product consumption required by the various activities, and Y_j the final demand of households and public institutions (and firms in the case of capital goods). The result for the activity over a financial year within the geographical area is as follows:

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[4] In this article, we ignore the disassembly phase of a vehicle. This phase cannot be ignored in absolute terms, but we think that with regard to the differential between EV and ICV its impact is very minimal.

[5] We therefore assume a rolling system. The purchase year should be seen more as a Renewal event which, in terms of a total fleet under ownership, is spread out in the same way as the usage phase. So there is no need to include any kind of interest rate.

$$I_j + X_j = K_{j\bullet} + Y_j + E_j \,. \tag{1}$$

Intermediate consumption arises from the volumes X_i of the various activities. We assume a linear dependence, giving the following breakdown:

$$K_{j\bullet} = \sum_{i \in J} K_{ji} \text{ and } K_{ji} = a_{ji} X_i \,. \tag{2}$$

We call the technical coefficients matrix $\mathbf{A} = [a_{ji} : j, i \in J]$. In matrix form, therefore, the total for all the activities is expressed as follows:

$$\mathbf{I}_J + \mathbf{X}_J = \mathbf{A}.\mathbf{X}_J + \mathbf{Y}_J + \mathbf{E}_J \,. \tag{3}$$

Assuming that final demand and foreign trade are known, domestic production is deduced from it as follows, where $\mathbf{U}$ is the identity matrix:

$$\mathbf{X}_J = (\mathbf{U} - \mathbf{A})^{-1}.(\mathbf{Y}_J + \mathbf{E}_J - \mathbf{I}_J) \,. \tag{4}$$

Replacing an ICV with an EV entails a change from $\mathbf{Y}_J$ to $\mathbf{Y}'_J = \mathbf{Y}_J + \delta\mathbf{Y}_J^{\mathrm{E}} - \delta\mathbf{Y}_J^{\mathrm{C}}$. From here, we can use the accounting model to draw the consequences regarding $\mathbf{X}_J$, which becomes $\mathbf{X}'_J = \mathbf{X}_J + \delta\mathbf{X}_J$. By linearity,

$$\delta\mathbf{X}_J = (\mathbf{U} - \mathbf{A})^{-1}.\delta\mathbf{Y}_J \text{, where } \delta\mathbf{Y}_J = \delta\mathbf{Y}_J^{\mathrm{E}} - \delta\mathbf{Y}_J^{\mathrm{C}} \,. \tag{5}$$

So far, this is a standard national accounting procedure. However, it is not enough to take account of a change in production and the associated technologies. Makign electric vehicles is a different industrial activity from making internal combustion vehicles, because both the distribution and use of the inputs are different. To reflect this specificity, we model an additional type of activity, with its own notation $j*$ and specific technical coefficients both for output from the different sectors (a_{ij*} for each $i \in J$) and for input (a_{j*i} for each $i \in J$).

In formal terms, J should strictly speaking be adjusted to $J* = J \cup \{j*\}$, the vectors $\mathbf{V}_J$ to $\mathbf{V}^*_{J*}$ etc. We will content ourselves with mentioning the conversion of matrix $\mathbf{A}$ into $\mathbf{A}*$, to use formulas (3), (4) and (5).

2.3 Fiscal model of activity, exchanges and energies

A country's government is able to find as many taxation sources as there are types of activity and economic processes… For our problem, we differentiate between general taxes on consumption (VAT) written $\mathbf{T}^Y$, taxes on production $\mathbf{T}^X$, import taxes $\mathbf{T}^I$ and export taxes $\mathbf{T}^E$.

We assume that each tax is proportional to the nature of the activity, with a specific coefficient. To stick with the French case, tax on production corresponds to various specific levies, including the *Cotisation Economique Territoriale* (national economic contribution) and corporation tax. We assume that it is proportional to Gross Operating Surplus (GOS, value added minus labour costs), if this is a positive figure. In addition, we first consider GOS proportionally to added value, and therefore ultimately to final demand. One proportionality leading to another, for each activity we take final domestic demand Y_j as the tax base for tax T_j^X.

In addition, we consider specific taxes on energy sources, expressed $\mathbf{T}^C$ with index an C for Carbon, because in France this notably includes TIPP (domestic tax on petroleum products).

We link them proportionally and specifically to each activity, to final demand, including consumption and specific energy sources.

In all, exogenous variations $(\delta\mathbf{Y}_J, \delta\mathbf{I}_J, \delta\mathbf{E}_J)$ and endogenous variations $\delta\mathbf{X}_J$ cause tax revenues to vary by

$$\delta R = (\mathbf{T}^Y + \mathbf{T}^X + \mathbf{T}^C).\delta\mathbf{Y}_J + \mathbf{T}^I.\delta\mathbf{I}_J + \mathbf{T}^E.\delta\mathbf{E}_J \,. \tag{6}$$

Finally, the tax element needs to incorporate specific policies relating to car ownership and usage, let us say a value of σ depending on which base year is chosen: in particular a subsidy for the purchase of an electric vehicle, or local exemptions from car parking fees, or the free supply of electricity on the public highway… Then

$$\delta F = \delta R - \sigma \,. \tag{7}$$

2.4 Social model

The social factors include return on investment, labour remuneration (including salaries and social contributions), together with unemployment benefits. We incorporate social revenues and expenditure into the national accounts, whilst retaining the possibility of isolating them if necessary.

Let us begin by expressing the value added per activity, V_j, as a function of production X_j and of the intermediate consumption that constitute an input into that production, K_{ij} :

$$V_j = X_j - K_{\bullet j}\,, \text{ where } K_{\bullet j} = \sum_{i\in J} K_{ij} = (\sum_{i\in J} a_{ij})X_j \,. \tag{8}$$

In matrix form, if the unit row vector by type of activity is expressed $\mathbf{u}_J = [1 : j \in J]$, the product $\mathbf{u}_J.\mathbf{A}^*$ is a row vector $[\sum_{i\in J} a_{ij} : j \in J]$. These elements are used as diagonal terms in the square matrix $\mathrm{diag}[\mathbf{u}_J.\mathbf{A}^*]$ whose non-diagonal terms are zero. Let us posit $\mathbf{B} = \mathbf{U} - \mathrm{diag}[\mathbf{u}_J.\mathbf{A}^*]$ to summarise the linear relationship between the added value vector and the production vector. Formally,

$$\mathbf{K}_{\bullet J} = (\mathbf{U} - \mathbf{B}).\mathbf{X}_J \text{ and } \mathbf{V}_J = \mathbf{B}.\mathbf{X}_J \,. \tag{9}$$

Then, still by activity type, we assume that the number of people employed η_j is proportional to the value added, with an inverse factor of “individual productivity” ρ_j (i.e. the average individual salary charged):

$$\eta_j = V_j / \rho_j \,. \tag{10}$$

We then express the average wage per employee as $w_j = w_j^{(i)} + w_j^{(s)}$, where $w_j^{(i)}$ is the net wage and $w_j^{(s)}$ the employee’s and employer’s social contributions. For each activity, the social contributions are $w_j^{(s)}\eta_j = V_j w_j^{(s)} / \rho_j$.

The row vector of sectoral coefficients $[w_j^{(s)} / \rho_j : j \in J]$, multiplied on the right by matrix $\mathbf{B}$, gives us the vector of sectoral coefficients for social contributions:

$$\mathbf{W}_J = [w_j^{(s)} / \rho_j : j \in J].\mathbf{B} \,. \tag{11}$$

From this, we can deduce the variation in social contributions associated with a variation in production $\delta\mathbf{X}_J$:

$$\delta S^{+} = \mathbf{W}_J . \delta \mathbf{X}_J \ . \tag{12}$$

If the government pays unemployment benefit at a net rate of z_j per unemployed worker in activity j (neutralising the social security contributions paid for the unemployed person), then the variation in social transfers associated with the variation in employment arising from a variation in production is the sum of social security contributions plus unemployment benefit,([6]) i.e.

$$\delta S = \mathbf{W}_J^{+} . \delta \mathbf{X}_J \text{ , where } \mathbf{W}_J^{+} = [(w_j^{(s)} + z_j)/\rho_j : j \in J].\mathbf{B} \ . \tag{13}$$

2.5 Provisional result

For the government, the balance of revenues net of expenditure for an exogenous variation $(\delta \mathbf{Y}_J, \delta \mathbf{I}_J, \delta \mathbf{E}_J)$ in final domestic demand and in foreign trade is

$$\delta B = \delta F + \delta S = \delta R - \sigma + \delta S \ . \tag{14}$$

To put values on the terms, we need first to establish the different proportionality coefficients that characterise the territory's production system and socio-economic circuit, then deduce the variation in production that arises from exogenous variations.

Formula (14) sums up the model. This is linear by nature, so that it can be applied to any number of private vehicles that may be affected by the internal combustion engine being replaced by the electric motor within a given territory.

We have limited the sequence of impacts by ignoring the effects on household demand of a variation in income (from capital or from work), and the effects of the spatial distribution of households (if the residential zone is outside the employment zone, then the ripple effects of consumption occur outside). We also ignore the income tax levied on individuals, apart from social contributions based on salary. In principle, the effects on driver consumption should be very small, since our comparison is based on two products that are equivalent in terms of total ownership cost. The effects on worker revenues are less clear, especially if there is a shift in employment between the main activities concerned (cars, electrical equipment, energy).

3. Data and assumptions

As of the end of 2011, we have annual statistics up to 2010 for the production accounts for each industrial sector in France, as well as for the number of people employed, salaries and social contributions (Insee, 2011). We also have an economic and social chart for 38 activity groups in base year 2009, in which car manufacturing is part of Transport Equipment Manufacturing, along with the rail and aerospace industries. A more detailed chart, identifying car manufacturing, is available in base 2007 and is our main source for the input-output model.

Within this model, we have situated final demand for the manufacture (para 3.1) and use of a car (para 3.2); in the process, we have modelled the construction of an electric car as an activity, deduced from recent information from the carmakers Renault and Nissan. We have kept base 2007 to evaluate the physical effects and social effects in terms of volume of

[6] Because the direction of transfer for the government needs to be taken into account: the government earns social contributions from a worker in employment, and also saves unemployment benefit, and therefore receives the sum of the two.

activity, but have as far as possible used 2011 values for the shift from volumes to values (para 3.3).

3.1 Composition of a car

The French new car market continues to be primarily supplied by carmakers of French origin, but vehicles imported by those carmakers and their foreign competitors account for more than 40% of the market (CCFA, 2011). In the 2007 national accounts, French production in “Car Manufacturing” was €67 billion, imports €38 billion and exports €47 billion, all exclusive of tax. The breakdown of domestic demand was 60% for households and public institutions, and 40% for businesses. Final household demand reflects the number of private cars sold and the average unit price recorded in recent years (approximately 2.3 million cars per year and €16.000 per car excluding VAT).

By relating intermediate consumption in the activity of “Car Manufacturing” to its production value, we obtained the technical coefficients for this activity, which reflect the typical composition of an ICV – though admittedly the large majority of the components are produced domestically.([7]) The main items are shown in Table 1 and covered below:

- Automobile construction, probably the engine: 30%.
- Metallurgy and metal processing: 12%.
- Automotive equipment manufacture: 9%.
- Chemicals, rubber, plastics: 7%.
- Financial, real estate and rental activities: 7%.
- Machinery: 5%.
- Business services, including research and development: 6%.
- Electrical and electronic equipment and components: 4%.
- Other intermediate consumption: 10%.
- Value added: only 10%.

This breakdown relates to intermediate consumption $[a_{ij} : i \in J]$ in activity j – “Automobile Construction” – and to its added value.

On the output side of this activity, intermediate consumption K_{ji} is low compared with production X_i in activities i, because a car is a finished product which companies acquire as capital goods, not for their own production processes.

Let us move onto the modelling of an EV. We treat the vehicle body and the battery as separate entities. Our assumptions about vehicle composition are set out in Table 1: we have assigned hypothetical values per car, deduced from those of the ICV for most fittings, but reduced by €1000 excluding tax for self-provision (electric motor easier to build). For the battery, we have counted €10.000 excluding tax under “Electrical and electronic equipment and components”.([8]) Finally, having assumed the same added value for an EV as for an ICV, we obtained a total production cost per EV (before tax), to which we applied the cost of each material supplied in order to obtain the technical coefficient of that material for column $j*$ of activity “EV Construction”, in technical coefficient matrix $\mathbf{A}*$. In addition, this activity row

[7] Which is increasingly less the case of France, although the foreign trade balances for the activities concerned are fairly equal.

[8] Our decision to allocate the manufacture of the battery to this activity, rather than to vehicle construction, is a deliberate one intended to take better account of probable intermediate consumption. A sensitivity test suggests that the impact of this decision on the scenario evaluation is minimal.

in the matrix was specified as zero apart from the diagonal self-provision term (engines, chassis).

Table 1: Production aspects of vehicle manufacture.

	Internal combustion vehicle		Electric vehicle	
Activity	**€ HT**	**%**	**€ HT**	**%**
Electric Vehicle Construction	0	0.0%	3350	14.2%
Farming, Agri-food Industry	9	0.1%	9	0.0%
Consumer Goods	433	3.0%	433	1.8%
Manufacture of IC Vehicle	4350	29.8%	0	0.0%
Automotive Equipment	1341	9.2%	1341	5.7%
Ship, Aircraft Rail Construction	8	0.1%	8	0.0%
Machinery	770	5.3%	770	3.3%
Electrical and Electronic Equipment	321	2.2%	10321	43.7%
Mineral Products	170	1.2%	170	0.7%
Textiles	174	1.2%	174	0.7%
Wood and paper	42	0.3%	42	0.2%
Chemicals, Rubber, Plastics	1084	7.4%	1084	4.6%
Metals and Metalworking	1742	11.9%	1742	7.4%
Electrical and Electronic Components	271	1.9%	271	1.1%
Fuels	84	0.6%	84	0.4%
Water, Gas, Electricity	87	0.6%	87	0.4%
Construction	18	0.1%	18	0.1%
Car Dealing and Repair	9	0.1%	9	0.0%
Wholesale and Intermediate Trade	99	0.7%	99	0.4%
Transport	50	0.3%	50	0.2%
Financial, Real Estate, Rental Activities	1105	7.6%	1105	4.7%
Services to Companies	823	5.6%	823	3.5%
Services to Individuals	34	0.2%	34	0.1%
Education, Health, Social Care	92	0.6%	92	0.4%
Administration	2	0.0%	2	0.0%
ADDED VALUE	1481	10.1%	1481	6.3%
TOTAL	**14600**	**100.0%**	**23600**	**100.0%**

3.2 Use of a car

The standard running of a car entails the consumption of goods and services: in principle, this consumption can be tackled simply in an input-output model, on a final demand basis. We specify this for an electric or internal combustion vehicle, for a technical and economic lifespan of 10 years with annual mileage of 15,000 km. It should be recalled that the average age of a vehicle in France’s automobile stock has increased from 7 to more than 8 years, and annual mileage, which rose in the 1990s, fell from 14,000 km in 2000 to 13,000 km in 2007 (CCFA, 2011). The parameters chosen describe conditions favourable to electric vehicles, i.e. sufficient daily travel to amortize the cost of the battery, but not too much to exceed battery range: we assume 15,000 km a year for 200 or 220 working days with a commuting distance of 30 or 40 km. Over 10 years, 150,000 km is compatible with 1000 recharge cycles for a battery with a range of 160 km, which meets the targets stated by the carmakers (CAS, 2011).

Let us reiterate our accounting convention laid out in section 2.1: we count each year in terms of vehicles sold, so for this year we need to count the use of the vehicle over its entire life cycle. In all, usage cost exceeds acquisition cost by a factor of around 1.4 for an ICV (excluding road toll or parking costs).

Use related consumption consists primarily of fuel or electricity, plus service, maintenance and insurance (Windisch, 2011).

Table 2 gives economic consumption, excluding tax, per vehicle type for a total mileage of 150,000 km over 10 years. Our standard ICV is a segment B diesel car, with above average annual mileage: the model is inspired by the Renault Clio, with average fuel consumption of 5 litres of diesel per 100 km. The main inspiration for the EV model is the Renault Zoe, assuming consumption of 15.5 kWh per 100 km travelled ([9]) and losses of 15% during recharging. Energy consumption is valued exclusive of tax at €0.70 per litre of diesel and €0.09 per kWh for electricity. We valued maintenance at €800 per year for the ICV and €500 per year for the EV, exclusive of tax. Insurance is rated at €440 per year for the ICV and €330 per year for the EV, based on recent insurance quotes, again exclusive of VAT.

Table 2: Use of a car: annual costs exclusive of tax

	VC	VE
Maintenance (€)	800	500
Insurance (€)	440	330
Mileage (km)	15,000	15,000
Energy per 100 km	5 l diesel	18 kWh
Price per unit of energy (€)	0.7	0.093
Energy cost (€)	525	251
Total cost of use (€)	1,765	1,081

3.3 Fiscal and social effects

With regard to tax, for each activity we specify a VAT rate of 19.6% in general and a tax on production based on production at the ratio recorded for the activity in 2007. In addition, we included a TICPE ([10]) of €0.45 per litre of diesel on car fuel, as well as specific taxes on electricity at a rate of 14% on the amount before tax plus VAT (MFDD, 2011b).

As regards the social aspects, in each activity we considered the employer's and employee's social contributions proportional to salary, for a total of 45% (Cf. Urssaf, 2011): by concatenation we establish a proportional relation with production. In addition, we set unemployment benefit at a fixed amount of 50% of the average net salary: this simplified method of valuation fairly accurately reflects the amounts stipulated under industrial agreements (Urssaf, 2011).

Table 3 summarises the social effects that concern us, for the main groups of production activities. The inequalities between the groups' individual indicators arise from the fact that the link between jobs and activities is not very precise.

[9] i.e. a range of 110 km if the battery has a capacity of 18 kWh

[10] Taxe Intérieure de Consommation des Produits Energétiques (domestic tax on the consumption of energy products): this term replaced TIPP in January 2011.

Table 3: Taxes and social transfers based on production.

Activity	Car Manufacture	Automobile Equipment	Metals	Fuels	Electricity, gas, water	Car dealers, repair	Services to Individuals
Production Xj (M€ pre-tax, Y2007)	67,310	27,662	97,453	58,477	78,675	46,248	179,886
Value added Vj (M€ pre-tax, Y2007)	6,828	5,933	29,315	6,068	27,350	27,675	95,147
Full-time jobs (1000s)	179	65	464	38	133	461	2325
Productivity Rj (€K/year)	29.0	70,1	39.6	42.0	77.5	34.1	26.9
Social contributions wj_s (€K/year)	13.1	31.5	17.8	18.9	34.9	15.3	12.1
Unemployment benefit, zj (€K/year)	8.0	19.3	10.9	11.6	21.3	9.4	7.4

3.4 Comments

We used several sources of information: French ministries, Urssaf, CAS, Insee, CCFA, information published by carmakers, plus certain assumptions of our own which we felt were plausible, in particular regarding the price of an EV and the price breakdown between car body, battery and charging terminal. On this subject, the policy of the carmakers seems to be to reduce the price of the individual battery, and at the same time to raise the price of the vehicle body, probably for a combination of commercial and economic reasons. The manufacturers also have latitude in whether they pass their R&D investment on electric vehicles to consumers in the short or long term.

The 2007 baseline is likely to become obsolete in the near future: more recent economic statistics show that car production fell by 30% between 2007 and 2009 – it would need to increase by 40% to return to its 2007 level.([11]) At the same time, French carmakers have increased their worldwide volumes: their production levels outside France are rising fast, reflecting international growth in the automobile market. ([12])

Transposition to another country would require all the assumptions to be adjusted: production structure and intermediate intersectoral consumption coefficients, balance sheet and production account structures for each activity, tax and social contribution rates, salaries and unemployment benefits, energy prices, and even specific taxes on automotive equipment (very high for an ICV in Denmark, for example).

4. Scenarios and results

In the two previous sections, we described the valuation model and the assumptions applied to the French domestic situation. We can now deduce the results, beginning with the aspects of the scenario relating respectively to the manufacture of a vehicle for each type of vehicle – ICV or EV – and to the use of a vehicle (para 4.1). Then we will examine different scenarios in which Manufacture and Usage take place inside or outside the country (para 4.2). After discussing all the results in terms of intersectoral policy and equity between taxpayers and

[11] This means that suppliers, and therefore indirect employment, are severely affected. Direct employment in car manufacturing has largely been maintained in the short term, but this would seem to threaten profitability and the situation is unlikely to last.

[12] In addition, we would point out several oddities in the presentation of the new car market in France. For one thing, the presentation talks about the number of vehicles, not the values, although the price of higher range cars is 3 or 5 times higher than that of lower range cars! For another, the numbers are given based on the carmaker's nationality of origin rather than the place of manufacture. However, in 2010, French auto manufacturers produced two thirds of their cars abroad, whereas some foreign manufacturers produce certain models in France (Toyota, Smart). The paradox is that the former manufacture middle or higher range cars in France, whereas the latter build small cars.

users (para 4.3), we will comment on the method of valuation in the light of the quantitative results (para 4.4).

4.1 Evaluation of the scenario elements

A scenario is a combination of manufacturing elements (code M) or usage elements (code U), per vehicle type. As our valuation method is linear, all that is needed is to combine the results of the individual elements to find the result of a scenario. Four elements are of fundamental importance: the domestic manufacture of an ICV (code CM, C for Combustion and M for manufacture) and its usage (code CU), the domestic manufacture of an EV (code EM) and its usage (code EU). Each element, code ab, is characterised by an elementary vector of end consumption per activity, $\delta\mathbf{Y}_{ab}$, established in section 3, from which we deduce sectoral production $\delta\mathbf{X}_{ab}$ using formula (4) provided in section 2, then the fiscal and social effects.

In the annex, Table A1 gives the consumption for each element, whilst Table A2 specifies the associated production. Worth noting are:

- The *substantial size of the values involved*, both for production and for the public finances (Table 4). This reflects the large *ripple effect* of manufacture, with a multiplier factor of around 4, whereas usage represents a multiplier of 3 for the ICV and 2.5 for the EV.
- For a single ICV, the total productive effect from manufacture and from usage are similar, around €56K and €51K respectively, excluding tax. The sectoral distribution is very different, focused on car construction and its inputs on the one hand, and on fuels, trade and insurance services on the other.
- For a single EV, manufacture has a much greater total productive effect than usage: the ratio between them is almost 4:1. The sectoral distribution differs markedly, for the same reasons as with an ICV, except that the Electricity Production activity replaces the Fuels activity.
- Between ICV and EV, the sum of the respective productive effects (M+U) is quite similar, around €107K and €116K respectively, i.e. within 10%. The underlying reason is that we chose a type of usagee in which the two vehicle types represent fairly similar costs for a user, and this similarity carries over to production, without being excessively affected either by the production system or by the tax regime.

The financial proceeds for the government are given in Table 4. They are substantial: over the life cycle of a vehicle, the financial proceeds amount to €36K both for an ICV and an EV, with a tiny difference excluding purchase incentive bonus. The proceeds from manufacture are almost equivalent to the vehicle's selling price before tax, while the proceeds from usage amount to 2/3 or 3/4 of the final cost excluding tax!

Replacing an ICV with an EV would be very slightly beneficial to the public purse, provided that it is manufactured and used within the country. A tax bonus of €5000 before VAT would reduce the financial proceeds from an EV by 16%, taking them markedly below those from an ICV.

Within the financial proceeds, social effects are very substantial and paramount: 65% for the ICV and 73% for the EV, let's say 70% for the sake of clarity. This provides retrospective justification for stating and evaluating them. Their distribution between manufacture and usage varies according to vehicle type: 45%-55% for an ICV compared with 71%-29% for an EV. Broken down by item, unemployment benefit represents around 38% of social contributions paid to the government: we incorporated into the accounts to reflect labour market conditions, which are currently difficult in France.([13])

VAT has an important role, representing 19% of proceeds. Additional energy taxes produce 9% of the proceeds for an ICV, but only 1% for an EV. Finally, taxes on production represent a not insignificant, though proportionally small amount, around €1000 per element, i.e. 5 or 6%.

On the tax side, the proceeds from one ICV would be €12.4K as compared with €9.5K for an EV before bonus, and €3.5K after bonus. These figures flesh out the results of CAS (2011) by including tax on production on both the manufacturing and usage sides.

Table 4: Values of the scenario elements (€ per car).

	Internal Combustion Vehicle		**Electric Vehicle**	
	Manufacture	**Usage**	**Manufacture**	**Usage**
Final expenditure	*14,600*	*17,650*	*24,400*	*10,814*
TVA	2,862	4,121	4,782	2,119
Energy surcharge		3,375		420
Tax on production	1,002	1,031	1,648	618
Gross social contributions	6,576	7,968	11,486	4,840
Unemployment benefit	4,018	4,869	7,019	2,958
Net social contributions	10,594	12,837	18,505	7,798
TOTAL excluding VE bonus	14,457	21,364	24,936	10,956
TOTAL with VE bonus	14,457	21,364	18,956	10,956

4.2 Definition and analysis of scenarios

In the baseline scenario, the manufacture and use of the vehicle take place within the territory under consideration.

We establish the following alternative scenarios:

1) Import: for a vehicle manufactured outside the territory but used inside it.
2) Export: the vehicle is manufactured within the territory but is not used there.
3) Replacing a domestically produced ICV with an imported EV.

In the Import scenario, the tax treatment of consumption is the same as in the base scenario. However, the tax on production in the manufacturing phase is lost to the territory, as are the social effects in manufacture. In this case, the EV loses its main revenue-generating elements. The financial loss to the domestic government is in excess of €8K per vehicle before bonus, and €14K after bonus!

However, the worst scenario is the "Competing Import", in other words replacing a domestically produced ICV with an imported EV, where a foreign-based carmaker offers a domestic consumer an attractive vehicle that persuades them to switch type. Indeed, excluding bonus and for the manufacturing phase, an imported EV would attract financial revenues of

[13] This inclusion is particularly important for a job retained "on the margin" of production, directly linked with business volumes. Since our model is linear, applying an assumption to the margin means that it applies to the entire volume of activity. As each of our scenarios is differential, this should not generate distortions.

€5K (VAT), whereas a domestically produced ICV brings in €14.5K, making a loss of €9.5K. Including usage, the loss would rise to €20K without bonus, and €26K with bonus!

The Export scenario contributes neither VAT (on manufacture or use), nor social effects and energy surcharges during use (ignoring the supply of spare parts). Its effects are restricted to the manufacturing phase, and in this respect an EV is almost twice as productive as an ICV, provided that no bonus is applied at export, i.e. that the bonus is only allocated for domestic use of the vehicle.

Out of all the scenarios, substitution for export is the most beneficial to the public purse, whereas replacing a domestically manufactured ICV with an imported EV is the most damaging. In the intermediate position, the baseline scenario with manufacture and usage occurring domestically is slightly positive without bonus, but markedly negative with. It is less unfavourable than the Competing Import scenario.

Table 5: Evaluation by scenario (€ per car).

	E-C, MI-UI	**Import**	**Export**	**Competitive import**
Net final domestic spend	*2,964*	*-4,916*	*9,800*	*-16,654*
VAT	-81	-81	0	-81
Energy surcharge	-2,955	-2,955	0	-2,955
Taxes on production	234	-413	647	-1,415
Gross social contributions	1,782	-3,128	4,910	-9,703
Unemployment benefit	1,089	-1,911	3,001	-5,930
Net social contributions	2,872	-5,039	7,911	-15,633
TOTAL without VE bonus	70	-8,487	8,557	-20,083
TOTAL with VE bonus	-5,910	-14,467	3,557	-26,063

4.3 Discussion

The financial outcome is very sensitive to the place where the vehicle is manufactured and used. The domestic authority needs to adjust its policy finely, to reflect inherent national conditions.

The outcome of the baseline scenario is slightly favourable to electric vehicles: the loss on fuel surcharges would be more than offset by the gains in social contributions. ([14]) To bring in these gains, the industrial operators need to keep industrial employment within the country and increase it in proportion with activity. This kind of cooperation with the general interest is less easy for governments to control than taxes on energy: herein lies a significant risk in the implementation of a policy in favour of electric vehicles.

Other specific tax arrangements can distort the results. In France, notably, fuel used by taxis is exempt from specific taxes (up to an annual quota), which would improve the financial outcome of the baseline scenario before bonus, and would similarly improve the outcome of the import scenario.

The results of the different scenarios cover a very wide scope, from the highly negative to the broadly positive: in other words, the development of electric vehicles is a risky undertaking for the public finances of a country, depending on its industrial competitiveness.

The bonus for purchasing an EV constitutes a government incentive, which reverses the outcome of the baseline scenario from slightly positive to markedly negative. It is difficult to

[14] In fact, the two items would be almost equal if along with TICPE we included the VAT that it generates.

justify on the grounds of the long-term goal of protecting the climate by reducing greenhouse gas emissions, because the advantage of the EV over the ICV in the usage phase, under our assumptions regarding mileage and unit consumption, only represents the equivalent of 21 tonnes of CO_2 for the energy mix of electricity production in France.([15]) The cost to the government of saving one tonne of CO_2 by replacing an ICV with an EV, in the baseline scenario, would be almost €300 after bonus; in the Import scenario, €400 before bonus and €700 after; in the worst-case scenario, €950 before bonus and €1200 after! All these costs are much higher than the costs of reduction in other sectors, in the short and medium term.

It is therefore worth asking whether a nationwide tax bonus is appropriate as an economic instrument. The climate benefit is insufficient, at least in the short and medium term. The same is true for energy factors, which are also part of the carbon economy. Local environmental priorities – improving air quality and reducing noise – should rather be tackled by local methods, obviously including a local bonus for using vehicles in town centres. As regards encouraging local manufacture, this gains no benefit from a bonus on purchases, which applies to any vehicle whereever it is made. By the same account, this is also true of the social aim of maintaining domestic employment. So all that remains for government are strategic questions of energy independence, which are relevant both to foreign trade and to very long-term risk management: the bonus is a very high price to pay for these under current conditions… Ultimately, the bonus would seem primarily to be an instrument of coordination, providing an incentive for consumers and reducing risks for carmakers. It is important that it should be applied only to vehicles that are used and manufactured domestically.

Looking further forward, let us imagine a radical change in fuel prices, resulting in the government having to remove the surcharge on consumption, which in turn would improve the financial outcome, before bonus, of replacing an ICV with an EV. This would nonetheless not justify the bonus, since in these circumstances it would be in drivers' personal interests to use an EV… In this eventuality, acting early to develop efficient EVs and effective industrial systems would seem to be a wise precaution in planning for the long-term. Facilitating research and development efforts is certainly a good economic instrument in this respect, not only for the EV but also for "smart" charging terminals which would be adaptable to the country's energy production systems. We would also recommend promoting local renewable energy production and encouraging local networks to manufacture equipment for this kind of production. This might be expected to have the indirect effect of stimulating the spread of electric vehicles, which would become more attractive for individuals who produce their own electricity. Reducing energy consumption would also seem to go without saying as an objective: nevertheless, its impact on the public finances remains to be considered, by comparing the revenues lost in the consumption phase with the potential gains in the production phase.

In summary, this discussion is about fairness between the taxpayer represented by government and the car user exposed to specific policies. It is also about geographical fairness between places where the use of EVs might develop, and places which would fund the public subsidies for this development through taxation. And it is also about fairness between the industrial operators in different sectors, as potential beneficiaries of public subsidies.

[15] If, for the usage phase, we count 3.1 tonnes CO_2 emitted per cubic metre of diesel consumed, and 0.085 tonnes CO_2 emitted per MWh produced in France, a lifetime mileage of 150,000 km emits 21 tonnes more CO_2 in ICV than in EV.

4.4 Methodological comments

The quantitative treatment provides retrospective evidence of the need for a sufficiently sensitive valuation model, in other words one that incorporates enough vertical and horizontal aspects. Both vehicle manufacture and use need to be taken into account, from a life-cycle analysis perspective, otherwise there is a risk of twofold or even three or fourfold errors on certain items. Location within or outside the country must also be covered, to avoid comprehensive errors both of sign and order of magnitude! Ripple effects also need to be included: different production activities, in particular automobile construction, are highly interdependent, and the values propagate within a complex system of production: here again, there is a risk of large-scale errors… And finally, the social accounts need to be taken into account, and not only the taxation aspects, again at the risk of substantial errors.

All these sensitivities greatly enrich the traditional framework of transport economics. At the conceptual level, they are affiliated in drawing their inspiration from economic and social analyses with a general economic equilibrium model of transport (e.g. Bröcker, 2004). However, we only look at the movements of the values, not price behaviour nor the behaviour of the microeconomic actors; on the other hand, we include vehicle manufacture and usage, which to the best of our knowledge is absent from existing economic equilibrium models in transport economics.

One limitiation of our model is its linear approach. The social aspects are based on a number of jobs per activity, assuming proportionality, in other words a constant level of efficiency. However, a significant priority for any company is to look for economies of scale, and therefore increasing efficiency for all resources, including human. The linearity of the model entails the risk that an application may overestimate the effects. Nonetheless, we believe that this risk is moderate for an emerging industrial activity such as EV production, because any emerging activity requires investments and therefore calls on the various activities at a more sustained rate than in standard running mode.

Here, we reach another limitation inherent to input-output models: a transformation in the system of production is difficult to fit into the model in its rapid development phase. We postulated a new industrial activity, with its consumption in normal running mode, but without its specific investments. Their omission undoubtedly leads us to underestimate the short-term economic and financial impacts, which would counterbalance the risk of overestimation caused by linearity.

5. Conclusion

From a factual perspective, we have shown that the manufacture and use of an automobile has a significant impact on the public finances. The French case has several salient features: an industrial infrastructure that allows local manufacture, a surcharge on end consumption of fuel, high rates of social contributions and benefits. In these circumstances, the return per vehicle for the public finances is slightly favourable to the VE compared with the ICV, before the EV purchase bonus, which would markedly reverse the comparative outcome. As part of an export strategy, the EV is more profitable to the public purse than the ICV. The worst scenario is the import of a foreign manufactured EV for domestic use, in preference to a locally manufactured ICV.

From a methodological perspectives, our valuation model has strengths and weaknesses. Its strengths are firstly that it deals with monetary values, whereas the traditional socio-economic evaluation in transport economics is very largely based on user well-being; secondly, that in "vertical" terms, it takes account of the activities of economic production, their relations through intermediate consumption between customer and supplier, and therefore the ripple effects; thirdly, that in "horizontal" terms it includes the economic and social effects of the different sources of taxation, and the social transfers based on working activity; and fourth, that it sets spatial limits on the public authority, by distinguishing between domestic and foreign territory All these strengths greatly enrich the traditional framework of transport economics.

The weaknesses relate to the input-output model on which the valuation is based. Firstly, we only know the intermediate consumption between economic activities for trade within the country, not foreign trade. Secondly, our model of an industrial infrastructure for the manufacture of the EV is of our own creation, and needs to be compared with reality in order to improve.

Despite these weaknesses, our valuation method is powerful in its breadth and its depth, and undoubtedly more robust than less integrated methods. Within the framework of the FORWARD E2 (Electromobility in Europe) European research project, it will be applied to several models, whether to differentiate between vehicle models for ([16]) or between national or regional areas, and to assess different political instruments, not only incentive bonuses but also European or national standards and local measures in favour of electromobility.

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6. References

BCG (2009) *The Comeback of the Electric Car? – How Real, How Soon, and What Must Happen Next*. The Boston Consulting Group, authored by Book M., Groll M., Mosquet X., Rizoulis D., Sticher G., BCG Focus: online accessible via **www.bcg.com/publications**.

Bröcker J (2004) *Computable General Equilibrium Analysis in Transportation Economics*. Chapter 16 in Hensher D.A. et al, *Handbook of Transport Geography and Spatial Systems*, pp. 269-289. Elsevier.

CAS *Centre d'Analyse Stratégique* (2011) *La voiture de demain : carburants et électricité*. Rapport de la mission présidée par Jean Syrota. La Documentation Française, Paris. http://www.strategie.gouv.fr/content/rapport-la-voiture-de-demain-carburants-et-electricite-0

CCFA (2011) *L'industrie automobile française : analyse et statistiques*. Rapport sur l'année 2010. http://www.ccfa.fr/IMG/pdf/ccfa_anastated2010-2.pdf

CE Delft (2011). *Impacts of Electric Vehicles – Deliverable 4: Economic analysis and business models*, April, www.cedelft.eu, accessed on 2011-20-09.

CGDD (2011). *Les véhicules électriques en perspective : Analyse coûts-avantages et demande potentielle*, Rapport #41 du Commissariat Général au Développement Durable.

Deutsche Bank (2009), Lache R., Galves D., Nolan P., Global Market Research, *Electric Cars : Plugged In - A mega theme gains momentum*, November 3.

[16] cf. la gamme du constructeur américain Tesla Motors qui cible le segment sportif de luxe

Deutsche Bank Research (2011). *Electromobility – Falling costs are a must*, published in collaboration with the Institut der Deutschen Wirtschaft, Koeln. Online accessible via www.dbresearch.com.

Draper, M., Rodriguez E., Kaminsky P., Sidhu, I., Tenderich, B. (2009). *Economic Impact of Electric Vehicle Adoption in the United States*, Technical Brief, Global Venture Lab, Center for Entrepreneurship and Technology, U.C. Berkeley.

ESMT (2011), *MMEM – Marktmodell Elektromobilitaet*, online accessible via http://mmem.eu/abschlussbericht (accessed on 2011-30-11).

Gregoir S (2008) *L'élaboration des données de comptabilité nationale et l'analyse économique*. 12ème colloque de l'Association de comptabilité nationale Paris, 4-6 juin.

Insee (2011) Tableau Economique et Social de 2009 en 38 branches. Available on-line at http://www.insee.fr/fr/indicateurs/cnat_annu/base_2005/donnees/xls/tes_38_2009.xls

Leurent F, Windisch E (2011) Triggering the development of electric mobility: a review of public policies. *Eur. Transp. Res. Rev*. Vol. 3. pp. 221–235. DOI 10.1007/s12544-011-0064-3. Available on-line at http://www.springerlink.com/content/ghq570268853q546/fulltext.pdf

MFDD *Ministère français chargé du développement durable* (2011a). *Prix et marges des produits pétroliers en France et dans l'Union Européenne*. Document d'information, http://www.developpement-durable.gouv.fr/Cours-prix-et-marges-en-France-et,14648.html

MFDD (2011b) *Principes généraux de construction des tarifs réglementés d'électricité. 11 décembre 2009* (mis à jour le 10 mars 2011) – Direction Énergies et climat. http://www.developpement-durable.gouv.fr/Principes-generaux-de-construction.html

MFDD (2011c) *La fiscalité des hydrocarbures applicable au 1er janvier 2011*. http://www.developpement-durable.gouv.fr/La-fiscalite-des-hydrocarbures,11221.html

Nemry F., Brons M. (2011), *Market penetration scenarios of electric drive vehicles*. Proceedings of the European Transport Conference 2011. 10-12 October, Glasgow, Scotland.

Quinet, E (1998) *Principes d'économie du transport*. Economica, Paris.

Ursaaf *Unions de recouvrement des cotisations de sécurité sociale et d'allocations familiales* (2011). *Taux des cotisations du régime général de sécurité sociale*. Information sur site web http://www.urssaf.fr/employeurs/baremes/baremes/taux_des_cotisations_du_regime_general_01.html

Windisch E (2011) *The uptake of electric vehicles in the Paris region : a financial impact analysis of policy measures, market development and user characteristics on total costs of ownership.* Proceedings of the European Transport Conference 2011. 10-12 October, Glasgow, Scotland.

7. Annex

Table A1: Final demand per car (€ excluding tax).

	Internal Combustion Vehicle		Electric Vehicle	
	Manufacture	**Usage**	**Manufacture**	**Usage**
	DeltaY_CM	**DeltaY_CU**	**DeltaY_EM**	**DeltaY_EU**
Electric Vehicle Manufacture	0	0	23,600	0
Agriculture, Agri-food Industry	0	0	0	0
Consumer Good s	0	0	0	0
Car Manufacture ICV	14,600	0	0	0
Car Equipment	0	0	0	0
Ship, Aircraft, Rail Construction	0	0	0	0
Machinery	0	0	0	0
Electrical and Electronic Equipment	0	0	500	0
Mineral Products	0	0	0	0
Textiles	0	0	0	0
Wood and Paper	0	0	0	0
Chemicals, Rubber, Plastics	0	0	0	0
Metallurgy and Metal Processing	0	0	0	0
Electrical and Electronic Components	0	0	0	0
Fuels	0	5,250	0	0
Water, Gas, Electricity	0	0	0	2,511
Construction	0	0	0	0
Car Dealing and Repair	0	8,000	0	5,000
Wholesale and Intermediate Trading	0	0	0	0
Transport	0	0	0	0
Financial, Real Estate, Rental Activities	0	4,400	0	3,303
Services to Businesses	0	0	0	0
Services to Individuals	0	0	300	0
Education, Health, Social Care	0	0	0	0
Administration	0	0	0	0
TOTAL	**14,600**	**17,650**	**24,400**	**10,814**

Table A2: Domestic production per car (€ excluding tax).

	Internal Combustion Vehicle		**Electric vehicle**	
	Manufacture	**Usage**	**Manufacture**	**Usage**
	DeltaX_CM	**DeltaX_CU**	**DeltaX_EM**	**DeltaX_EU**
Electric Vehicle Construction	0	0	27,505	0
Agriculture, Agri-food Industry	486	364	802	198
Consumer Goods	1,193	454	1,548	251
VC Automobile Construction	20,876	760	105	469
Automotive Equipment	2,255	464	1,887	277
Ship, Aircraft, Rail Construction	156	61	220	29
Machinery	2,078	666	2,693	307
Electrical and Electronic Equipment	1,011	302	15,505	153
Mineral Products	977	335	1 398	176
Textiles	502	82	568	42
Wood and Paper	574	319	915	163
Chemicals, Rubber, Plastics	3,995	1,887	4,961	630
Metallurgy and Metal Processing	6,603	1,451	8,899	684
Electrical and Electronic Components	949	351	2,191	193
Fuels	3,257	20,464	4,421	3,118
Water, Gas, Electricity	878	646	1,244	3,589
Construction	311	530	464	333
Automobile Dealing and Repair	39	8,073	48	5,041
Wholesale and Intermediate Trading	445	289	694	129
Transport	636	974	1,050	419
Financial, Real Estate, Rental Activities	6,910	11,818	10,775	7,488
Services to Businesses	1 712	283	2,510	126
Services to Individuals	322	334	851	183
Education, Health, Social Care	282	183	410	99
Administration	38	130	62	57
TOTAL	**56,485**	**51,222**	**91 .725**	**24,155**